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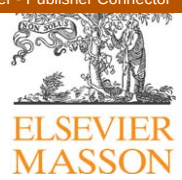

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ORIGINAL ARTICLE

Infected total hip arthroplasty treated by an irrigation-debridement/component retention protocol. A prospective study in a 12-case series with minimum 2 years' follow-up

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KEYWORDS
Debridement;
Component retention;
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Summary
Introduction: Treatment of infection after total hip replacement (THR) is complex and costly. Debridement with component retention is an attractive solution. Success rates in the literature vary widely (18—90%) according to patient selection criteria. The present prospective study assessed the selection criteria used in our department.
Methods: A prospective study included all patients ($n = 210$) surgically managed for infection following THR between November 2002 and December 2008. Patients underwent debridement in case of acute infection: i.e., early postoperative infection within 1 month of THR, or secondary hematogenic infection with less than 2 weeks' evolution. Beyond this deadline or in case of implant loosening, implant replacement was performed. The debridement series thus comprised 12 patients (mean age, 69 ± 11.3 years; mean evolution from contamination was 4.8 ± 3.5 days). Bacteriologically adapted antibiotherapy was administered for 6 weeks intravenously followed by 6 weeks per os. Mean follow-up was 40 ± 23 months. No patient was lost to follow-up. The success criterion was apparent eradication of infection at a minimum 2 years, defined by absence of clinical, biological or radiological signs of infection and of death attributable to infection or treatment. Where infection was suspected, hip aspiration or peroperative sampling determined recurrence (identical bacterium) or reinfection (different bacterium).
Results: There were nine cures (75%) and three failures. Mean Postel Merle d'Aubigné Score, at end of follow-up, was 17 ± 2. The three failures involved the same bacteria (two *streptococci* [one group B, one group G] and one *Enterococcus faecalis*) as implicated in the primary infection.
Discussion: The present results are comparable to those in the literature but poorer than for implant exchange. The technique remains, however, an interesting alternative, allowing less complex surgery and lower cost.

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Conclusion: Patient selection criteria need refining so as to increase success rates with this technique.
Level of evidence: Level IV; prospective non-randomized non-comparative study.

Introduction

Treating infection in total hip replacement (THR) is complex and costly [1,2]. Debridement with components retention is an option which, under certain conditions, may be interesting. The surgical operation is lighter from the patient's point of view, allows earlier recovery of joint function, and is less costly than implant replacement. Success rates in the literature vary widely, from 18 to 90% [3—16], and depend on patient selection criteria. Rigorous selection, large-scale debridement and precise bacteriological adaptation of antibiotherapy are the keys to success [8]. Several risk factors for failure have been identified [8,12]: essentially, more than 2 weeks' evolution of infection, comorbidity, and fistula. The present prospective study assessed the selection criteria employed in our department.

Patients and methods

Inclusion and exclusion criteria

A prospective observational study was run from November 2002 to December 2008. On our departmental decision tree, debridement was indicated in case of acute infection: i.e., on Tsukayama's classification [14], early postoperative infection less than 1 month post-implantation or secondary hematogenic infection of less than 2 weeks' evolution. Secondary infection was diagnosed for a combination of remote infection, positive blood-culture and detection around the implant of a bacterium other than those commonly associated with peroperative contamination [17]. Exclusion criteria included radiologic signs of bone infection (e.g., periosteal apposition or osteolysis around the implant) or of implant loosening. In case of more than 2 weeks' evolution or of loosening, implant replacement was indicated. Surgery was followed by adapted antibiotherapy maintained for a maximum of 3 months. Only cases of curative debridement (i.e., without prescription of lifetime suppressive antibiotics) were included in the study. In case of failure, debridement was not repeated, and some other treatment option was undertaken. Patients gave written informed consent and the study received ethics committee approval.

Success criterion

The criterion of success was apparent resolution of the initial infection at a minimum 2 years' follow-up, defined by absence of clinical, biological and radiological implant infection signs or of death directly implicating the infection or treatment.

Patients

Between November 2002 and December 2008, 210 THR implant infections were managed surgically in the department. One-stage replacement was performed in 106 patients, 2-stage replacement in 76 patients and resection or coaptation in 16. Twelve patients were managed by curative debridement with retention of components (with or without femoral head or acetabular insert replacement): five men, seven women; mean age, 69 ± 11.3 years. On the American Society of Anaesthesiologists classification, 1 patient was ASA-1, 10 were ASA-2 and 1 was ASA-3. The initial pathology underlying THR was primitive osteoarthritis of the hip in eight patients, secondary osteoarthritis in three (one post-tuberculosis [with negative bacteriology at implantation], secondary to radiation therapy in one and to Legg-Calve-Perthes disease in one) and osteonecrosis of the hip in one. Mean evolution between estimated first signs and debridement was 4.8 ± 3.5 days (range, 1 to 11 days). Contamination was early postoperative in two patients who had undergone THR in the department, and probably secondary in 10. The entry point was identified in eight patients (Table 1). Clinically, onset was sudden in all cases, with mean $39 \pm 0{,}5\,^{\circ}C$ fever, chill, hip pain and varying degrees of functional impairment. Mean preoperative Postel Merle d'Aubigné Score was 8.9 ± 4.2. Soft tissue was normal in seven patients, inflammatory or abscessed in four, and one patient developed a productive fistula 4 days before surgery. Biologically, mean leukocyte count was 10,763/mm^3 (range, 3,830 to 27,280), erythrocyte sedimentation rate 74 (range, 43 to 120) and C-reactive protein 186.2 mg/l (range, 72 to 335). Preoperative hip aspiration was performed in 11 patients. In one patient, a simple Cathlon catheter sample was taken from the scar, isolating group G streptococcus. In 10 aspirates, the culprit bacterium was identified (one being negative due to preoperative antibiotherapy), with a mean joint-liquid cell-count of 108,969/mm^3 (range, 2400 to 580,000) including a mean 93% (range, 77 to 99%) polynuclear neutrophils. Seven of the 12 patients had cemented implants. Mean hospital stay was 22 days (range, 14 to 35 days). Mean follow-up was 3.5 years, with no loss to follow-up.

Surgery

Open debridement used the previous approach. Synovectomy was large (anterior, posterior, superior and inferior), involving all abscessed and necrotic joint and periprosthetic regions and any periarticular ossifications. The implant was dislocated so as to treat all interfaces, and tested peroperatively for loosening. Where feasible, the femoral head and/or acetabular insert was replaced: in four cases for the femoral head

Table 1 Entry point and isolates.

	Age(yrs)	Sex	Number of previous operations on site	Infection evolution (days)	Type of contamination	Entry point	Culprit bacterium
Patient 1	58	M	1	10	Secondary		*Staphylococcus aureus MS*
Patient 2	74	M	1	1	Secondary	Digestive	*Streptococcus group B*
Patient 3	83	F	1	7	Early postop.		*Streptococcus group G + Staphylococcus aureus MS*
Patient 4[a]	81	F	1	2	Secondary	Cutaneous	*Streptococcus group B*
Patient 5	74	F	3	3	Secondary	ENT	*Streptococcus pneumoniae*
Patient 6	85	F	3	9	Secondary		*Citrobacter freundii*
Patient 7	63	F	2	4	Secondary	Genital	*Enterococcus faecalis*
Patient 8[a]	68	M	2	11	Secondary	Urinary	*Enterococcus faecalis*
Patient 9	53	M	2	2	Secondary	Dental	*Streptococcus mitis*
Patient 10[a]	78	F	2	3	Secondary	Cutaneous	*Streptococcus group G*
Patient 11	56	M	1	2	Early postop.		*Streptococcus group G*
Patient 12	59	F	1	4	Secondary	Digestive	*Streptococcus group B*

[a] Failures.

alone, with associated polyethylene insert replacement in two.

Antibiotherapy

Preoperative antibiotherapy was systematically initiated following the preoperative hip aspiration. It consisted of i.v. biantibiotherapy at effective dose, initially probabilistic then quickly adapted to the aspiration findings. No local antibiotherapy was administered. I.v. antibiotherapy was maintained for 6 weeks, followed by 6 weeks' oral administration. Tolerance was satisfactory.

Bacteriology

At least three staggered deep peroperative samples were taken. Isolates are shown in Table 1.

Results

Each patient underwent a single debridement. The 2-year success rate was 75%. Mean Postel Merle d'Aubigné score at end of follow-up was 17 ± 2.

There were three failures due to recurrence of infection implicating the primary bacterium (Table 2).

The first failure concerned an 81 year-old woman with type-2 diabetes, ASA 3. The cemented THR had been implanted 2 months previously, for primitive osteoarthritis of the hip. Group B streptococcus was implicated. Contamination was considered to be secondary, as the entry point, confirmed by a local bacteriological sample, was a bedsore on the heel contracted during her previous admission. The interval between first signs of infection and debridement was 2 days. Antibiotherapy was maintained for 6 weeks, by i.v. route only, as the patient failed to take her oral treatment. Relapse occurred 2 weeks after end of antibiotherapy, with total functional impotence without fever or chill, and was confirmed by hip aspiration. Given the patient's age and terrain, minimal debridement was undertaken, with 6 weeks' i.v. antibiotherapy followed by a lifetime suppressive regime (cefalexin $1\,g \times 3$ daily). With this treatment, infection appeared stable at 5 years' follow-up.

The second failure concerned a young man operated on for bladder stones. Infection was secondary to the urinary entry point. Following a documented urinary infection implicating *Enterococcus faecalis*, the patient showed hip pain, fever, chill and functional impairment. The interval between the first signs of infection and debridement with femoral head replacement was 11 days. Recurrence was observed 3 months after the end of antibiotherapy, with hip pain but no fever. Hip aspiration confirmed recurrence implicating the initial bacterium. One-stage replacement was associated to adapted antibiotherapy (6 weeks i.v. followed by 6 weeks per os). At 4 years' follow-up, the infection had resolved.

The third failure concerned a 78-year-old woman, without comorbidity, who had undergone previously implant replacement by trochanterotomy for recurrent dislocation. The infection was considered probably secondary, in view of a skin wound sustained 4 days before the onset of clinical signs and of the type of bacterium (group G streptococcus) isolated. Relapse occurred a few days after the end of antibiotherapy, as confirmed on hip aspiration. One-stage replacement was associated to adapted antibiotherapy. At 2 years' follow-up, the infection had resolved.

Discussion

There are, to the best of our knowledge, no reports of prospective studies of debridement in infected THR. The present 75% success rate at a minimum 2-years' follow-up after a single surgical procedure is comparable to the most recent reports (Table 3). At a minimum 2-years' follow-up, Tsukayama et al. [16] had a 68% success rate after a single surgical procedure, and Marculescu et al. [12] 60% after iterative debridement in hip and knee implants taken together.

Table 2 Analysis of the three cases of recurrence implicating same bacterium.

	Patient 4	Patient 8	Patient 10
Age	81	68	78
Sex	F	H	F
Morbidity	Type-2 diabetes	Bladder stones	
ASA score	3	2	2
Age of THR (months)	2	55	2
Type of THR	Cemented	Cemented	Cemented
Number of previous operations on site	1	2	2
Soft-tissue status	Inflammatory	Inflammatory	Inflammatory
Estimated infection evolution (days)	2	11	3
Type of contamination	Secondary	Secondary	Secondary
Entry point	Cutaneous	Urinary	Cutaneous (probable)
Isolate	*Streptococcus group B*	*Enterococcus faecalis*	*Streptococcus group G*
Femoral head and/or insert replacement	No	Femoral head	No
I.v. antibiotics (weeks)	6	6	6
Per os antibiotics (weeks)	0	6	6
Time to relapse after cessation of antibiotherapy (months)	< 1	3	< 1
Revision	Debridement + lifetime antibiotics	1-stage replacement	1-stage replacement
Follow-up (years)	5	4	2

Estes et al. [14] reported a 90% success rate at a minimum 2-years' follow-up after a 2-stage procedure. All these results, however, are poorer than found with 1- or 2-stage THR implant replacement [16,18].

Several risk factors for failure were reported. The most widely accepted is the interval to debridement after onset of signs, with elevated risk of failure after eight days according to Marculescu et al. [12], four according to Meehan et al. [10] and two according to Brandt et al. [4]. The other failure factors reported in the literature are: comorbidity, fistula and implant loosening [6,9,12]. Resection quality is a success factor: resection should be large and meticulous.

In our department during the study period, only 12 out of 210 patients met the criteria for debridement with retention of components: i.e., postoperative infection following THR performed less than 1 month previously or presumed acute infection with less than 2 weeks' evolution between onset of clinical signs and surgery, without implant loosening and with known bacterium. These conditions enhance the chances of success and appear necessary for debridement to be indicated but not sufficient to ensure the success rates obtained with implant replacement.

The present series lacked power to perform multivariate risk-factor analysis; even so, we put forward the following hypotheses. In the first case of failure, the causes may have been advanced age in an ASA-3 patient, and the duration of antibiotherapy, which was not extended by a per os course due to non-compliance. In the second case, the THR was almost 5 years old; the infection was considered acute, but may have been an acute episode in a chronic infection in a patient with a long history of bladder stones, for which he had been operated on: the infection implicated *Enterococcus faecalis*, also isolated in urine cytobacteriology. In the third case, the patient had previously undergone revision by trochanterotomy, requiring repair by cerclage only the projecting part of which could be removed on debridement: the remaining material may have been responsible for the relapse.

Two of these failures were thus probably due to previously described risk factors: comorbidity and insufficient resection. In the third case, evolution had probably been longer

Table 3 Examples of studies of debridement in infected total hip replacement.

Author	Infection site	Date	Number of patients	Mean F.U.(yrs)	Number of procedures	Success rate (%)
Tsukayama et al. [16]	Hip	1996	41	3.8	1	68
Tattevin et al. [7]	Hip Knee	1999	34	1.6	1	38.2
Lhotellier [8]	Hip	2002	52	4.7	1	79
Meehan et al. [10]	Hip Knee	2003	19	3.9	1 to 3	89.5
Marculescu et al. [12]	Hip Knee	2006	99	2	1 to 4	60
Aboltins et al. [13]	Hip Knee	2007	20	2.7	1 to 4	90
Estes et al. [14]	Hip Knee	2010	20	2.4	2-stage	90

than thought: it is very difficult to be sure that an infection is acute [17], and estimated intervals between clinical onset and revision probably underestimate evolution as there is an occult interval between implant contamination and clinical expression which may amount to several days. Secondary infection is thus a very different matter from acute per- or perioperative infection, where the date of implantation and thus the earliest possible date of contamination are known with certainty. In the present series, all three failures involved infection deemed to be secondary.

Debridement is certainly a cheaper treatment option than implant replacement, when it meets with success. In our own departmental cost analysis [1], the duration of the stay in the surgery department and in postoperative care and rehabilitation accounted for the extra cost associated with management of infected THR as compared to infection-free revision and primary THR. In the case of debridement, the mean stay in surgery was shorter and home care was more often possible for i.v. antibiotherapy monitoring with physiotherapy sessions at home. Moreover, the cost does not include the mean cost of the implant. It should, however, be borne in mind that failure of a component-retention procedure entails the extra cost of subsequent replacement.

Certain authors reported increased success rates with increased number of procedures [10,12,13], but at the cost of extending hospital stay and multiplying the number of surgical operations; we feel that this is of little benefit in terms of quality of life for the patient or of economy for the community, compared to primary 1-stage replacement.

The main limit of the present study was the small number of patients, preventing statistical analysis of risk factors for failure.

Conclusion

Debridement is certainly an interesting treatment option, but the success rate is clearly lower than for implant replacement. In case of relapse, all of the benefit for both patient and community is wiped out. Comorbidity should always be included in the decision tree and, in case of doubt as to the real time of evolution in an infection considered to be secondary, we recommend implant replacement.

Conflict of interest statement

None.

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